D07 FIU SITE CHARACTERIZATION: SUMMARY

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Anne Balsley	CCB Administrator/DCS	10/06/2011

See Configuration Management System for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
1.0	06/15/2010	NEON.FIU.000243.CRE	Initiation
A	09/15/2010	NEON .FIU .000256 .CRE	Add FCC hitlist, update reports
B	12/10/2010	NEON .FIU .000278 .CRE	UPDATE SEE CRE
C	03/29/2011	ECO-00157	Great Smoky Mtn National Park site added. See ECO for additional changes
D	09/23/2011	Eco-00279	Update to new document number's/template throughout document.

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1 DESCRIPTION

1.1 Purpose

The data summarized here is used to inform the site design activities for NEON project Teams, EHS (permitting), FCC, ENG and FSU. This document summarizes the FIU site characterization data collected, analyzed, and described in the FIU D07 Site Characterization: Supporting Data (AD[01]).

1.2 Scope

This document summarizes the FIU site characterization data for D07 tower locations: Oak Ridge National Lab Walker Branch (Core) and Mountain Lake Biological Station (Relocatable 1) and Great Smoky Mountain National Park (Relocatable 2). Accuracy of our GPS locations are only as good as the methodology used, i.e., GPS units to ~ ±3 m.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	NEON.DOC.011037 FIU D07 Site Characterization Supporting Data.docx
AD[02]	NEON.DOC.011018 WID between FIU and FCC
AD[03]	NEON.DOC.011008 FIU Tower Science Requirements
AD[04]	NEON.DOC.011029 FIU Precipitation Collector Site Design Requirements

2.2 Reference Documents

RD[01]	NEON.DOC.000008 NEON Acronym List
RD[02]	NEON.DOC.000243 NEON Glossary Of Terms
RD[03]	
RD[04]	

2.3 Acronyms

m.a.s.l.	Meters above sea level
m.a.g.l.	Meters above ground level

2.4 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

3 ORNL WALKER BRANCH

3.1 Desired ecosystem

Table 1. Ecosystem at Oak Ridge Nat'l Lab, The Walker Branch Watershed.

Ecosystem Type	Management activity
Eastern Uplands Deciduous forest	Managed Forest

NEON Advanced tower site at Oak Ridge is located within The Walker Branch Watershed, which is located on the U. S. Department of Energy's Oak Ridge Reservation in Roane County, Tennessee. The ecosystem we are interested in is the mixed hardwood forest. Candidate tower location was lat 35.964618, long -84.280557. After FIU site characterization, we determine the tower location to be at 35.96412, -84.28260 to avoid measuring flows that is channeled by the valley from the southern direction. New tower location is microsited toward southwest direction for ~190 m and toward the hill top. It is next to dirt access road and power. This is a closed-canopy ecosystem. Canopy height is ~28 m around tower site with lowest branches at ~10 m above ground level. No obvious strata observed at canopy. New location is near the original tower location and closer to access road. The ecosystem in interest is the same type.

Table 2. Ecosystem and site attributes for Oak Ridge Nat'l Lab, The Walker Branch Watershed site.

Ecosystem attributes	Measure and units
Mean canopy height	28 m
Surface roughness[a]	1-to-1.4 m
Zero place displacement height[a]	24.5 m
Structural elements	Closed canopy, understory present, uniform
Time zone	Eastern time
Magnetic declination	5° 0' W changing by 0° 5' W/year

Note, [a] From field survey.

3.2 Site Design and Tower Attributes

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut (short-side of instrument hut is perpendicular to the **Instrument hut orientation vector)**. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially, in this case, level 6 being the upper most level at this tower site.

Table 3. Site design and tower attributes for the ORNL Walker Branch Advanced site.

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed area			247° to 293° and 68° to 90°		Clockwise from first angle
Tower location	35.96412,	-84.28260	--	--	new site
Instrument hut	35.96423,	-84.28256			
Instrument hut orientation vector	--	--	90° - 270°		Short face parallel to 0° - 180°
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	180°	--	
DFIR	35.96180	-84.28646			
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				7.0	m.a.g.l.
Level 3				16.0	m.a.g.l.
Level 4				22.0	m.a.g.l.
Level 5				30.0	m.a.g.l.
Level 6				38.0	m.a.g.l.
Tower Height				38.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the south will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

DFIR (Double Fenced International Reference) for bulk precipitation collection will be located at an existing open clearing, which is used by ORNL as NADP wet/dry deposition collection site and used by ATDD as a test bed for meteorological sensors. DFIR is on the south west side of tower and ~430 m away from tower. Power is available at site. **Wet deposition collector** will collocate at the top of the tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks.

- There is always a boardwalk from the instrument hut to the tower
- If there is a boardwalk on the south side of the tower, it is never underneath the radiation booms, and it is more than 4 m from the side of the tower
- There is never a boardwalk within 4 m of the tower, except where it perpendicularly intersects the tower for access
- The boardwalk to access the tower is not on any side that has a boom.
- There is never boardwalk within 10 m of a soil plot, except where it perpendicularly intersects a soil plot for access.

Specific Boardwalks at ORNL Walker Branch Advanced site utilize the orientation outlined in Table 3, and **option 8 in Figure 3, note: with anemometer boom facing 180° south**.

- Boardwalk is from the access dirt road to instrument hut, pending landowner decision
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to the soil array (optional from access road to soil array)
- No boardwalk from the soil array boardwalk to the individual soil plots
- No boardwalk needed at DFIR site

3.3 Soil Attributes

Fullerton cherty silt loam, 5 to 12 percent slopes. During construction a soil profile shall be dug at each core site and samples throughout the profile will be extracted. The soil array vector is ***from*** the soil plot closest to the tower ***toward*** the farthest soil plot.

Table 4. Summary of soil array and soil pit information at Oak Ridge. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	14 m
Latitude and longitude of 1st soil plot OR direction from tower	35.96424°, -84.28266°
Direction of soil array	253°
Latitude and longitude of FIU soil pit	35.96453°, -84.28276°
Dominant soil type	Fullerton cherty silt loam, 5 to 12 percent slopes
Expected soil depth	>2 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths** *
0-0.30 m (gravelly silt loam)	0.15 m†
0.30-0.69 m (gravelly silt clay loam)	0.50 m†
0.69-1.63 m (gravelly clay)	1.16 m†
1.63-2.00 m§	1.82 m
2.00 m	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.

†Expected depths for CO_2 sensors (actual depths will be determined based on horizons in the FIU soil pit)

§Soil description not available at this depth

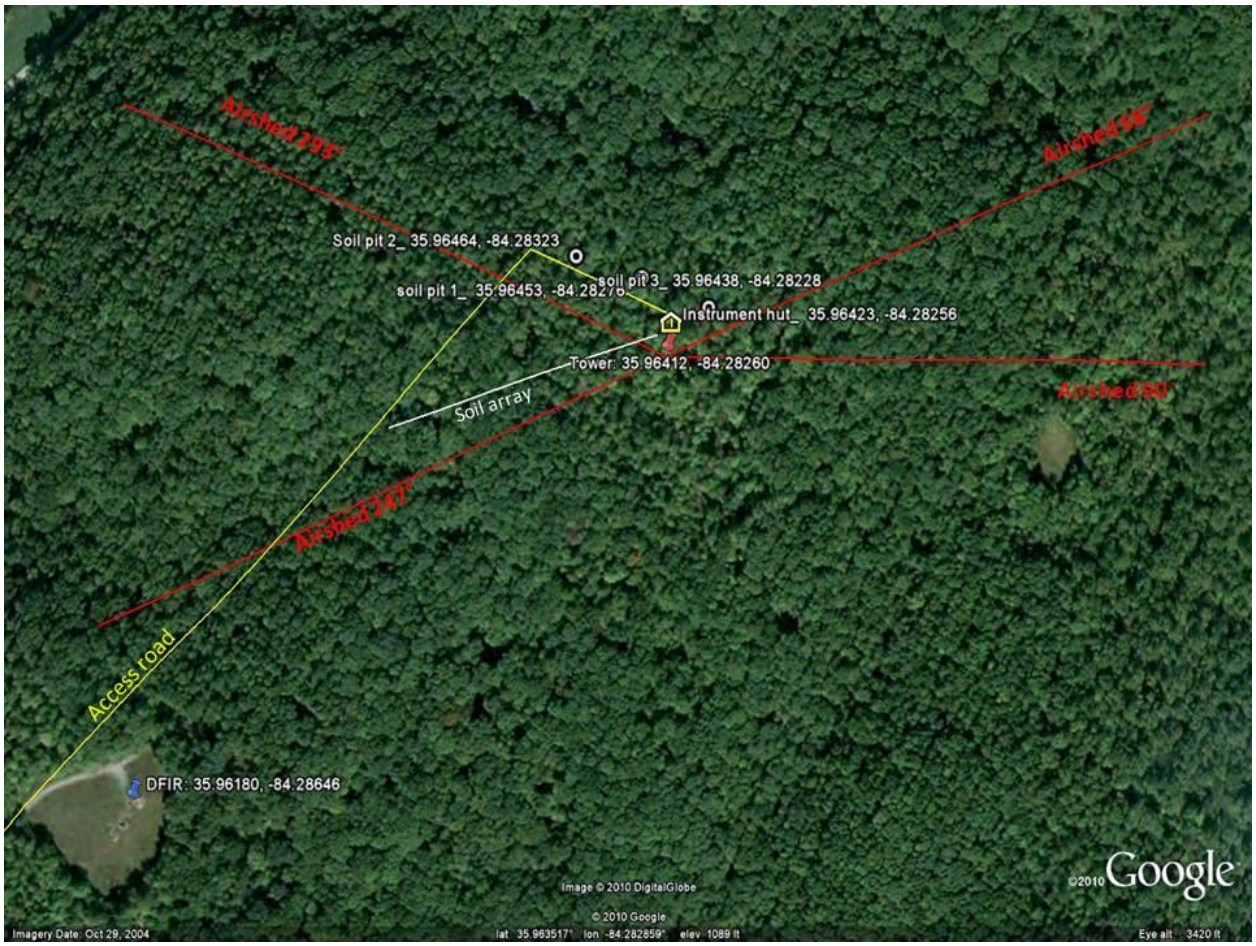


Figure 1. Site layout for ORNL Walker Branch Advanced tower site

i) New tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 247° to 293° (clockwise from 247°) and 68° to 90° (clockwise from 68°) are the airshed areas that would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut. iv) Purple pin indicates the DFIR location

3.4 Information for ecosystem productivity plots.

The tower at ORNL Walker Branch Advanced site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (deciduous hardwood forest). Airshed areas at this site are from 247° to 293° (clockwise from 247°) and from 68° to 90° (clockwise from 68°), and 90% signals for flux measurements are within a distance of 800 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots be placed within the boundaries of 247° to 293° (clockwise from 247°) or 68° to 90° (clockwise from 68°).

3.5 Issues and attentions

According to our communication with Dr. P. Mulholland, the site contact at ORNL, he is ok with NEON micrositting tower to the new location. He said currently there is almost no active experiments at this forest site. The site location should not conflict with other experimental needs.

The DFIR site we picked is in an existing open area, which is the closest clearing to our tower location that we could find. This open area is currently use by ORNL as a NADP wet/dry deposition colletion site and used by ATDD as meteorologiocal sensor test bed. Dr. P. Mulholland expressed interests to let us take over the NADP wet/dry deposition instruments and site if we are doing same measurements. He felt that it is getting more difficult for him to get funding to maintain the measreuments. He also said if the open space is not large enough to meet the class 1 or 2 criteria for DFIR, it is possible to cut down some rows of trees to enlarge the space, but a proposal is required for further discussion with regarding permit and approvals. Dr. J. Kochendorfer from ATDD implied that some unused equipment could be removed from the site to free up space for our DFIR. But that needs to be checked and confirmed by Dr T. Meyers.

Dr. J. Kochendorfer from ATDD mentioend some gas emissions from the buildings on the south or west sides of the forest could potentially affect source area (flux) measurements. He said that could be the reason Ameriflux tower at Walker Branch was relocated to Chestnut Ridge. But he was unclear what the gas species was/is and where the emission sources could be. We will need communicate with Dr T. Meyers about this issue for further information.

One inconvenient issue here is that scientist with foreign nationality need to be escorted all the time. Hopefully, NEON can negotiate a special permit without such restriction for our foreign scientists.

4 MOUNTAIN LAKE BIOLOGICAL STATION, RELOCATEABLE TOWER 1

4.1 Desired ecosystem

NEON candidate Relocatable 1 tower site at Virginia (37.371796, -80.524488) is located within Mountain Lake Biological Station boundary. Because the major fetch area for the candidate tower location is over a creek and drainage area to the west, we propose a new tower site at 37.37828, -80.52484 to maximize our measurements over the natural hardwood forest ecosystem. The analysis and results we provide below are based on the new site at 37.37828, -80.52484.

Table 5. Ecosystem at the Mountain Lake Biological Station Relocatable site.

Ecosystem Type	Management activity
Eastern Deciduous Forest (Oak Dominant)	Managed Forest

The ecosystem type that we will measure at the proposed new site is oak forest. The terrain is flat and ecosystem is very uniform around tower site. The mean canopy height around tower is ~18 m with lowest branch at ~8 m above ground. Seedlings and saplings understory varies from 5 to 12 m in height without obvious strata. Ferns and other annual plants form the understory at floor lever with height < 1m. Canopy is closed and canopy area density is estimated to be 5 in summer and 2.5 in winter.

Table 6. Ecosystem and site attributes for the Mountain Lake Biological Station Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	18 m
Surface roughness[a]	1 m
Zero place displacement height[a]	15 m
Structural elements	Closed-canopy, uniform, homogeneous
Time zone	Eastern time
Magnetic declination	8° 2' W changing by 0° 2' W/year

Note, [a] From footprint analysis.

4.2 Site Design and Tower Attributes

We use tower as the index. Tower location is the center point. All other information is based on the site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut (short-side of instrument hut is perpendicular to the **Instrument hut orientation vector)**. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially, in this case, level 6 being the upper most level at this tower site.

Table 7. Site design and tower attributes for D07 Mountain Lake Biological Station Relocatable site

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed			250° to 315° (major) and 70° to 135°		Clockwise from first angle
Tower location	37.37828,	-80.52484	--	--	new site
Instrument hut	37.37816,	-80.52479			
Instrument hut orientation vector	--	--	90°-270°		Short face parallel to 180° - 360°
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	360°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				4.0	m.a.g.l.
Level 3				8.0	m.a.g.l.
Level 4				14.0	m.a.g.l.
Level 5				20.0	m.a.g.l.
Level 6				28.0	m.a.g.l.
Tower Height				28.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the north will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. **Wet deposition collector** will be collocated on the top of tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks.

- There is always a boardwalk from the instrument hut to the tower
- If there is a boardwalk on the south side of the tower, it is never underneath the radiation booms, and it is more than 4 m from the side of the tower
- There is never a boardwalk within 4 m of the tower, except where it perpendicularly intersects the tower for access
- The boardwalk to access the tower is not on any side that has a boom.
- There is never boardwalk within 10 m of a soil plot, except where it perpendicularly intersects a soil plot for access.

Specific Boardwalks at Mountain Lake Biological Station Relocatable site utilize the orientation outlined in Table 7, and **option 3 in Figure 3 with boom facing north (360°).**

- Boardwalk is from the access road to instrument hut, pending landowner decision
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower

- Boardwalk from to the soil array
- No boardwalk from the soil array boardwalk to the individual soil plots

4.3 Soil Attributes

The dominant soil type is Fluvaquents, nearly level. The soil array vector is ***from*** soil plot closest to the tower ***toward*** the farthest soil plot from the tower.

Table 8. Summary of soil array and soil pit information at Mountain Lake. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	30 m
Latitude and longitude of 1st soil plot OR direction from tower	37.37840°, -80.52515°
Direction of soil array	290°
Latitude and longitude of FIU soil pit	37.37778°, -80.52426°
Dominant soil type	Fluvaquents, nearly level
Expected soil depth	>2 m
Depth to water table	0 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.33 m (loam)	0.17 m†
0.33-1.04 m (loam)	0.69 m†
1.04 -1.65 m (fine sandy loam)	1.35 m†
1.65-2.00 m§	1.83 m
2.00 m	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.
†Expected depths for CO_2 sensors (actual depths will be determined based on horizons in the FIU soil pit)
§Soil description not available at this depth

4.4 Information for ecosystem productivity plots.

The tower at Mountain Lake Biological Station Relocatable site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (hardwood forest). Airshed at this site is from 250° to 315° (clockwise from 250°, major airshed) and from 70° to 135° (clockwise from 70°, secondary airshed), and 90% signals for flux measurements are within a distance of 800 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots are placed within the major airshed boundaries of 250° to 315° (clockwise from 250°).

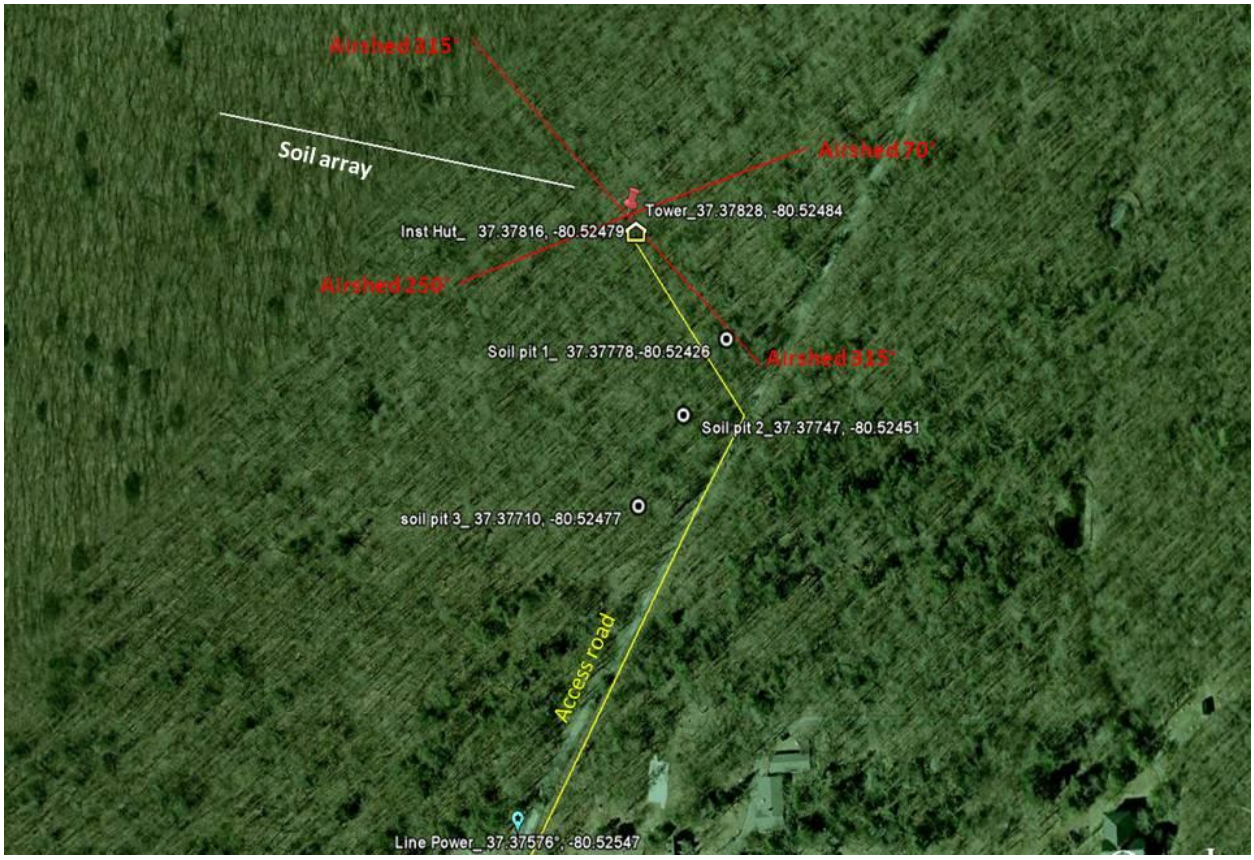


Figure 2. Site layout for Mountain Lake Biological Station Relocatable site

i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 250° to 315° (clockwise from 250°, major airshed) or from 70° to 135° (clockwise from 70°, secondary airshed) that would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

4.5 Issues and attentions

There are three concerns at this tower site.

First is security. Highway Sate Route 613 is actively used by public for recreation activities in the sourrounding areas. Vandalism or damage of facilities, although rare, remains a concern if the tower structure and instrument hut are visible from the road, which is more likely in winter after leaves fall.

Second concern is boundary lines on the north and west of the tower site. The tower location and instrument hut are inside the Mountain Lake Bioklogical Sation property according to the boundary map. But, during site visit, we found some wooden stake marks on trees on the north side of new tower location that looked like boundary line marks, which is more toward south than the boundary map indicates. Dr E. Nagy, our site contact, tried to identify the boundary lines on north and west, but wasn't sucessful. He said there was no active activities in that area. Most boundaries marks cannot be reconganized anymore. He suggested we should finish this report using the tower location we picked and make him a copy of the report. He will then bring this report to talk with the owners on north and west side of boundary. He doesn't think it will be a problem. The ecosystem is uniform here. The new tower location can be moved south <100 m and east <40 m if adjustment is necessary. But tower

location must be at least 60 m from the roadside. Instrument hut should be moved as well to keep its relative location to the tower.

The third concern is that the major airshed area is on the west side of tower and outside boundary. It will require additional negotiation and permits for FSU EP plots.

5 GREAT SMOKY MOUNTAIN NATIONAL PARK (GSMNP), RELOCATEABLE TOWER 2

5.1 Desired ecosystem

Table 9. Ecosystem at the Great Smoky Mountain National Park site.

Ecosystem Type	Management activity
Hardwood deciduous forest	Managed as a wildland

NEON candidate Relocatable tower site at Tennessee is located within Great Smoky Mountain National Park. The original candidate site was at 36.6847, -83.5000 at the foot of a large mountain. A new tower location at 35.68895, -83.50195, used here in this report was chosen by all parties in part i) to limit the construction and operation disturbance, ii) replace an existing tower that was zoned for 'conditional use', so that no new petition or change in land use would be needed, and iii) not affect the current viewshed and maintain the natural the beauty of the area. The ecosystem around the tower and in the airshed is closed-canopy hardwood deciduous forest that includes oaks and maples. Canopy height is ~30 m. Seedlings and saplings are abundant and dense.

Table 10. Ecosystem and site attributes for GSMNP tower site.

Ecosystem attributes	Measure and units
Mean canopy height	30 m
Surface roughness[a]	3 m
Zero place displacement height[a]	25 m
Structural elements	Closed deciduous hardwood forest, diverse and dense understory
Time zone	Eastern time zone
Magnetic declination	5° 34' W changing by 0° 4' W/year

Note, [a] From field observation.

5.2 Site Design and Tower Attributes

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 11. Site design and tower attributes for the GSMNP alternative Relocatable tower site.

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan or best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed			Wind mainly blows from SE and NW		No local wind data available to define the major airshed

			approximately along the valley line of 140°-320°.		boundary. Nighttime drainage flows from S, SW and E along the mountain slopes are also expected.
Tower location	35.68896,	-83.50195	--	--	new site
Instrument hut	35.68905,	-83.50208			
Instrument hut orientation vector	--	--	135°- 315°		longwise
Instrument hut distance z	--	--	--	16	
Anemometer/Temperature boom orientation	--	--	230°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				7.0	m.a.g.l.
Level 3				16.0	m.a.g.l.
Level 4				25.0	m.a.g.l.
Level 5				34.0	m.a.g.l.
Level 6				45.0	m.a.g.l.
Tower Height				45.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

According to windroses from Franklin Airport, TN (~52 km South of NEON Relocatable site at GSMNP), the prevailing wind direction blows from northwest (280° to 350° clockwise from 280°, major airshed) or from south (100° to 260° clockwise from 100°, secondary airshed) throughout the year. However, because of the complexity of the mountain terrain, the wind pattern at this airport is like not representative for the wind patterns at NEON tower location. But, no other wind data at tower location or within a reasonable distance to tower location is available to represent this site by the time this report is written. Further wind pattern analysis will be needed after NEON tower is established and collects wind data more than a year. By examining the terrain map, it is likely that wind mainly blows from southeast and northwest approximately along the valley line of 140°-320°. But no local wind data available to define the exact airshed boundary. We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes. Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwest will be best to capture most undistorted signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. **Wet deposition collector** will be collocated on the top of tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which

will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36' wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). Material is not known, but must be fire proof, and in some locations the site is seasonally flooded and inundated with water. Boardwalks may also provide a scratching structure for grazing animals that in turn, would wear and unduly impact the site. Site by site evaluations must be done.

Specific boardwalks at this Relocatable site:

- Gravel path from access point to the interpretation platform (if built)
- Well-defined marked path from the interpretation platform to instrument hut
- Boardwalk from the instrument hut to the tower and intersect tower on north face
- Marked path to the soil array
- No boardwalk or marked path to the individual soil plots

The relative locations between tower, instrument hut and boardwalk can be found in the Figure below:

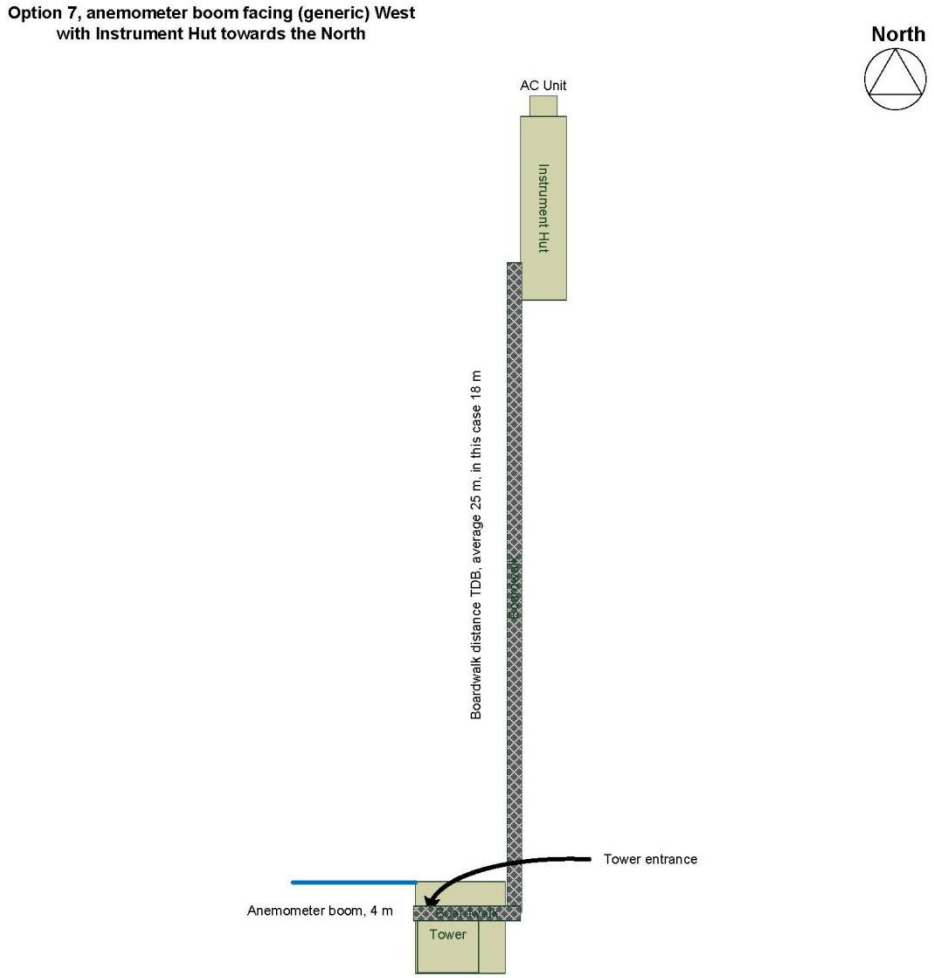


Figure 3. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the north towards the tower.

This is just a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At this site, the boom angle will be 230 degrees, instrument hut location is on the northwest toward tower, the distance between instrument hut and tower is 16 m. The instrument hut vector will be SE-NW (135^{o}-315^{o}, longwise).

Figure 4. Site layout for GSMNP alternative Relocatable site

i) new tower location is presented (Red pin), ii) Airshed boundary lines are not presented. Prevailing winds blow from SE and NW approximately along the valley line of 140°-320°. But no local wind data available to define the exact airshed boundary iii) Yellow line is the suggested access road to instrument hut.

5.3 Soil Attributes

Due to the small and undefined size of the area available for NEON infrastructure, the soil plots do not follow a standard pattern. Instead, coordinates are provided for each soil plot. The exact location of each soil plot may be microsited to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc).

Dominant soil series at the site: Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony. The taxonomy of this soil is shown below:
Order: Inceptisols
Suborder: Udepts- Aquepts
Great group: Humudepts- Humaquepts
Subgroup: Typic Humudepts- Typic Humaquepts
Family: Loamy-skeletal, isotic, mesic Typic Humudepts- Fine-loamy, isotic, mesic Typic Humudepts-Loamy-skeletal, isotic, acid, mesic Typic Humaquepts

Series: Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony

Table 12. Summary of soil array and soil pit information at Great Smoky. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	NA (non-standard pattern)
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	25 m
Latitude and longitude of soil plot 1	35.688804, -83.502149
Latitude and longitude of soil plot 2	35.689193, -83.502304
Latitude and longitude of soil plot 3	35.689318, -83.501828
Latitude and longitude of soil plot 4	35.688930, -83.501672
Latitude and longitude of soil plot 5	35.688544, -83.501518
Direction of soil array	NA (non-standard design)
Latitude and longitude of FIU soil pit 1	35.687624°, -83.500381° (primary location)[~]
Latitude and longitude of FIU soil pit 2	35.687965°, -83.500045° (alternate 1) [~]
Latitude and longitude of FIU soil pit 3	35.688301°, -83.499678° (alternate 2) [~]
Dominant soil type	Spivey-Santeetlah-Nowhere complex, 8 to 15 percent slopes, very stony
Expected soil depth	>2 m
Depth to water table	0.15 to >2 m

Expected depth of soil horizons	**Expected measurement depths[*]**
0-0.33 m (Very bouldery sandy loam)	0.17 m[†]
0.33-1.14 m (Very bouldery fine sandy loam)	0.74 m[†]
1.14-1.22 m (Extremely bouldery sandy loam)	1.18 m[†]
1.22 m-2.00 m[§]	1.61 m
2 m	2 m

[*]Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.
[§]Soil description not available at this depth
[†]Expected depths for CO_2 sensors (actual depths will be determined based on horizons in the FIU soil pit)
[~]Soil pit locations were picked using Google Earth and it was difficult to determine how far they are from the road. Soil pit locations shall be close enough to the road to provide relatively easy access, but far enough from the road that the soil profile has not been disturbed by the road or activities associated with it.

5.4 Information for ecosystem productivity plots

We do not have good wind data for this site to define the airshed area with high confidence. However, by examining the terrain map, it is likely that wind mainly blows from southeast and northwest approximately along the valley line of 140°-320° due to the local terrain and valley landscape. But no local wind data available to define the exact airshed boundary. We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes. The tower at GSMNP relocatable site has been positioned to optimize the collection of the air/wind signals

both temporally and spatially for the most undistorted signals. 90% signals for flux measurements are within a distance of 800 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots be placed on the southeast and northwest areas of tower.

5.5 Issues and attentions

Weather data used for the windroses in this report are from Franklin Airport, TN (~52 km South of NEON Relocatable site at GSMNP). However, because of the complexity of the mountain terrain, the wind pattern at this airport is likely not representative for the wind patterns at NEON tower location. But, no other wind data at tower location or within a reasonable distance to tower location is available to represent this site by the time this report is written. Further wind pattern analysis will be needed after NEON tower is established and collects wind data more than a year. By examining the terrain map, it is likely that wind mainly blows from southeast and northwest approximately along the valley line of 140^{o}-320^{o}. But no local wind data available to define the exact airshed boundary. We will also expect to see air flows from south, southwest and east during nighttime due to the air drainage along the mountain slopes.

Tower location is in a valley at the foothill of large steep mountain slopes. Cold air drainage expected here, and likely will cause additional uncertainties in FIU data products. In addition, the GSMNPS building is within tower airshed (~250 m away). Wind will likely pick up the signals from those buildings and parking lot prior to reaching tower when wind blows from southeast.

This site is one of the sites that are designed to monitor the atmospheric chemistry and then scale to up to the region and continent. Because tower locates at the mountain foothill and wind is channeled by the valley, instead of being representative for the whole region, the atmospheric chemicals collected at the location will be mainly from the city of Gatlinburg, which is located on the NW toward tower for ~1.6 miles—making this a non-ideal location of atmospheric chemistry

Because of the complex landscape, valley terrain and large steep mountain slopes, it will be challenge to interpret the flux signals collected at the tower top. Therefore, science goals about atmospheric chemistry and flux measurements may have additional uncertainties at this site

An existing tower structure is currently at our tower location. National park will take it down prior the establishment of NEON tower. Exact nature and timing of its removal will be discussed with the park service.

Soil pit locations were picked using Google Earth and it was difficult to determine exactly how far they are from the road. Soil pit locations shall be close enough to the road to provide relatively easy access, but far enough from the road that the soil profile has not been disturbed by the road or activities associated with it. We fully expect that these soil pit locations will move based on input from the Great Smoky Mtn NP staff. Moreover, we do not know the boundaries of the conditional use area to best place the soil pits. It may be best to place them along the access path to the tower site itself.

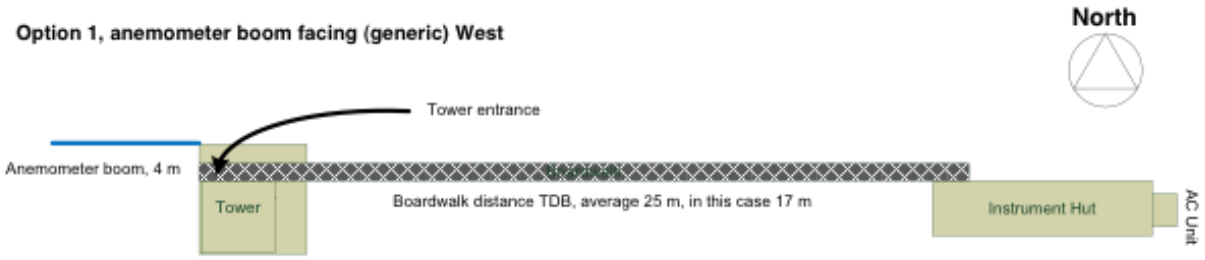
The land owner/representative stated during the site visit that NEON infrastructure had to be placed with a small area around the tower location, because this is located in an existing ‘condition use’ area. The exact size and shape of the area was undefined, but it is likely to be on the scale of tens of meters,

not hundreds of meters. As a result, all of the soil plots could not be placed within the expected tower airshed, which will reduce the linkages between information collected at soil plots and information collected at the tower. Nonetheless, the ecosystem structure at the soil plot locations is similar to the ecosystem structure at the tower site and in the expected airshed, therefore, this is not expected to substantially impact science at this site.

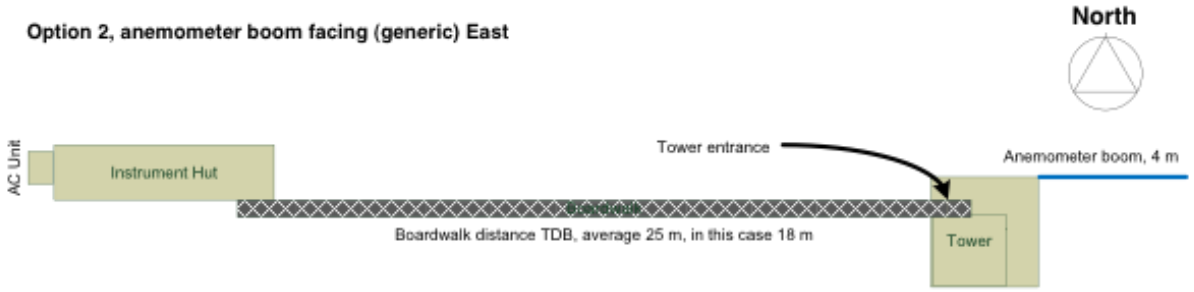
It is very rocky around tower site and location of the soil pits. In addition, it was difficult to see exactly where roads and paths were using Google Earth. As a result, it is possible that soil plots and soil pits will have to be microsited in order to avoid being too close to paths/roads or being located on rocky outcrops.

While selecting locations to place soil plots and soil pits, we were sensitive to National Park concerns in relation to minimizing disturbance and visibility, while also meeting our science goals. We expect to receive feedback from the National Park about the location of the soil plots and soil pits and we will work with the Park to ensure that their concerns at addressed while also meeting our science goals.

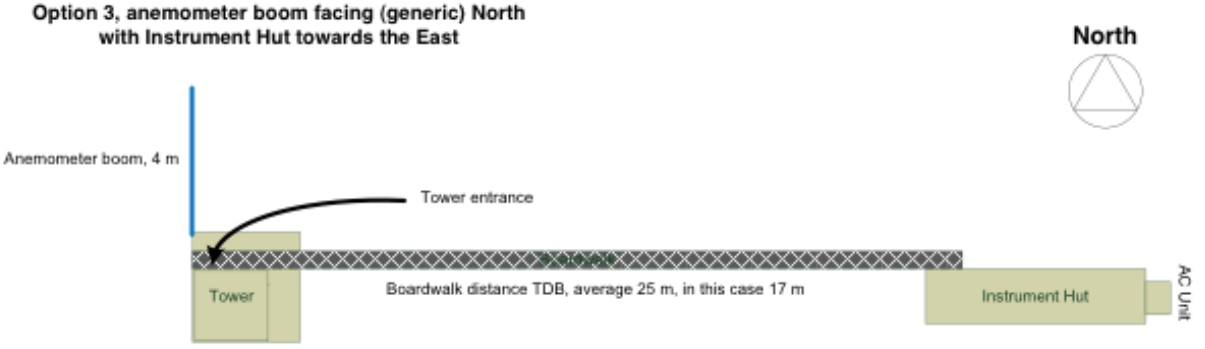
Option 1, anemometer boom facing (generic) West



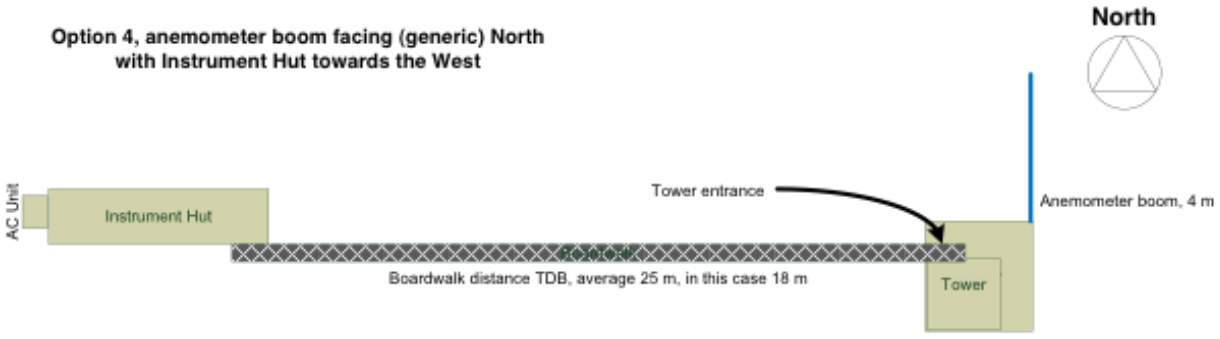
Option 2, anemometer boom facing (generic) East



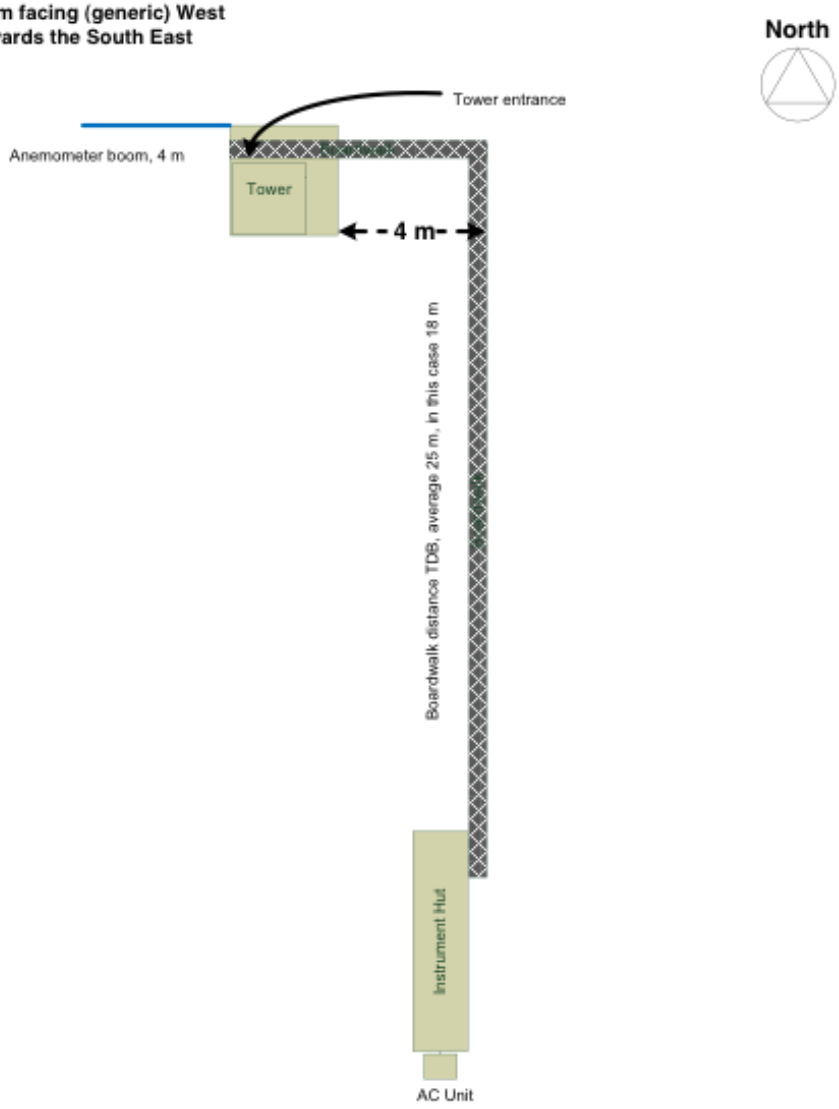
Option 3, anemometer boom facing (generic) North with Instrument Hut towards the East

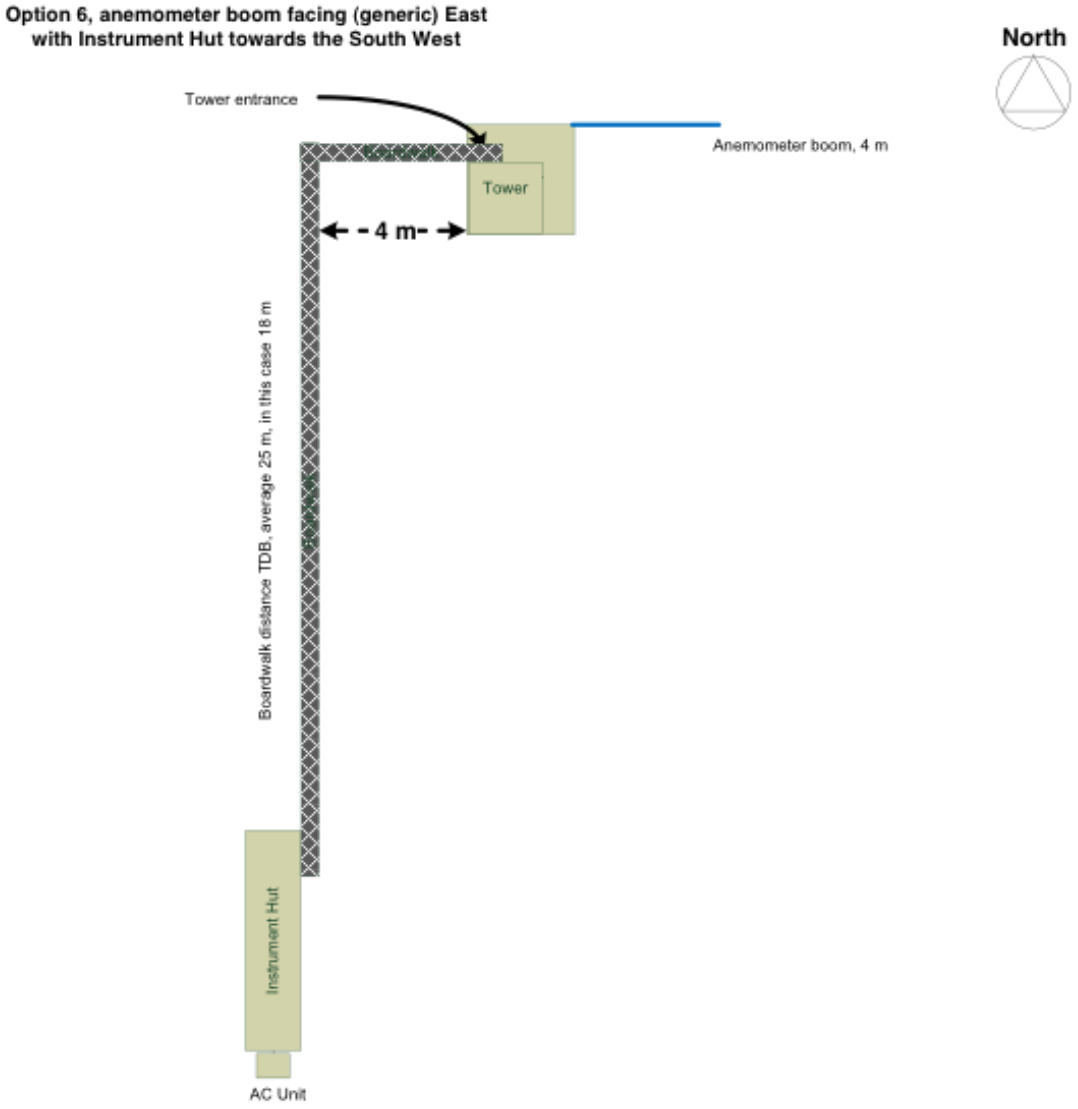


Option 4, anemometer boom facing (generic) North with Instrument Hut towards the West

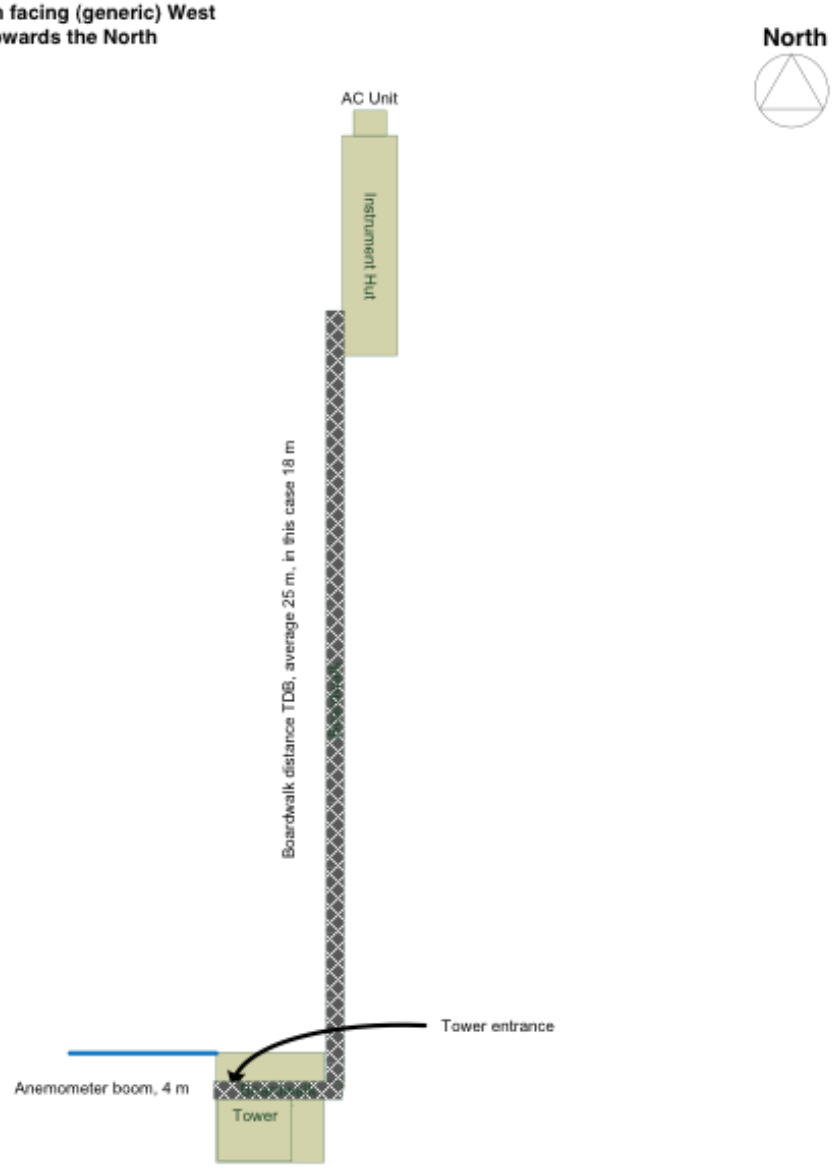


Option 5, anemometer boom facing (generic) West with Instrument Hut towards the South East




Option 6, anemometer boom facing (generic) East
with Instrument Hut towards the South West
North
Tower entrance
Anemometer boom, 4 m
Tower
- 4 m-
Boardwalk distance TDB, average 25 m, in this case 18 m
Instrument Hut
AC Unit

Option 7, anemometer boom facing (generic) West with Instrument Hut towards the North



Option 8, anemometer boom facing (generic) South with Instrument Hut towards the North

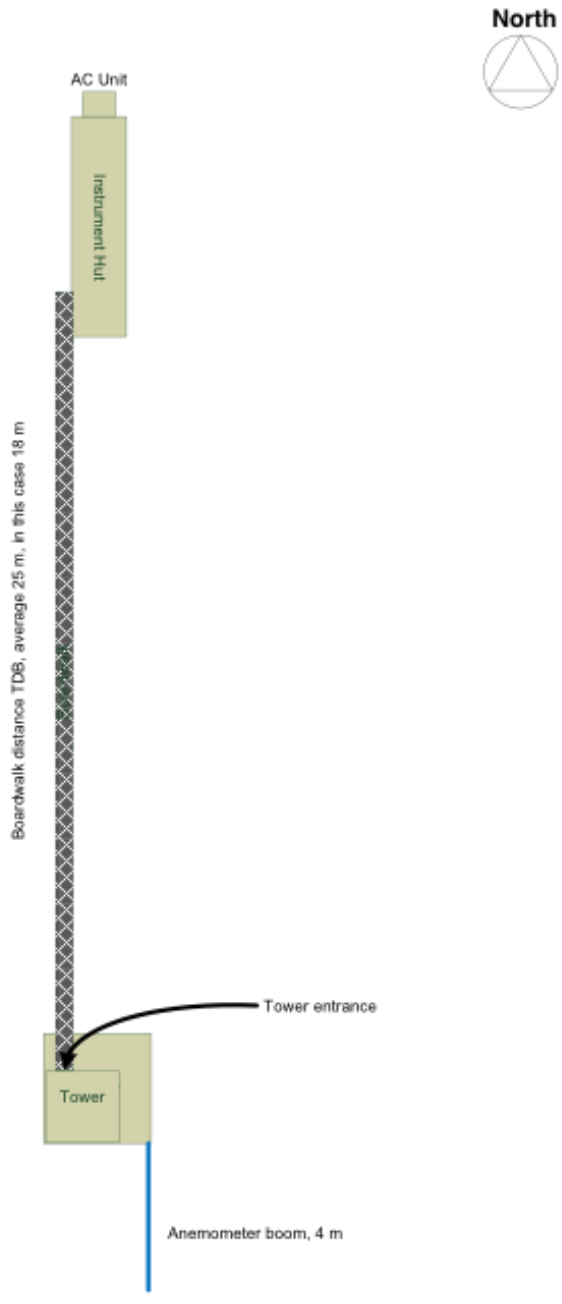
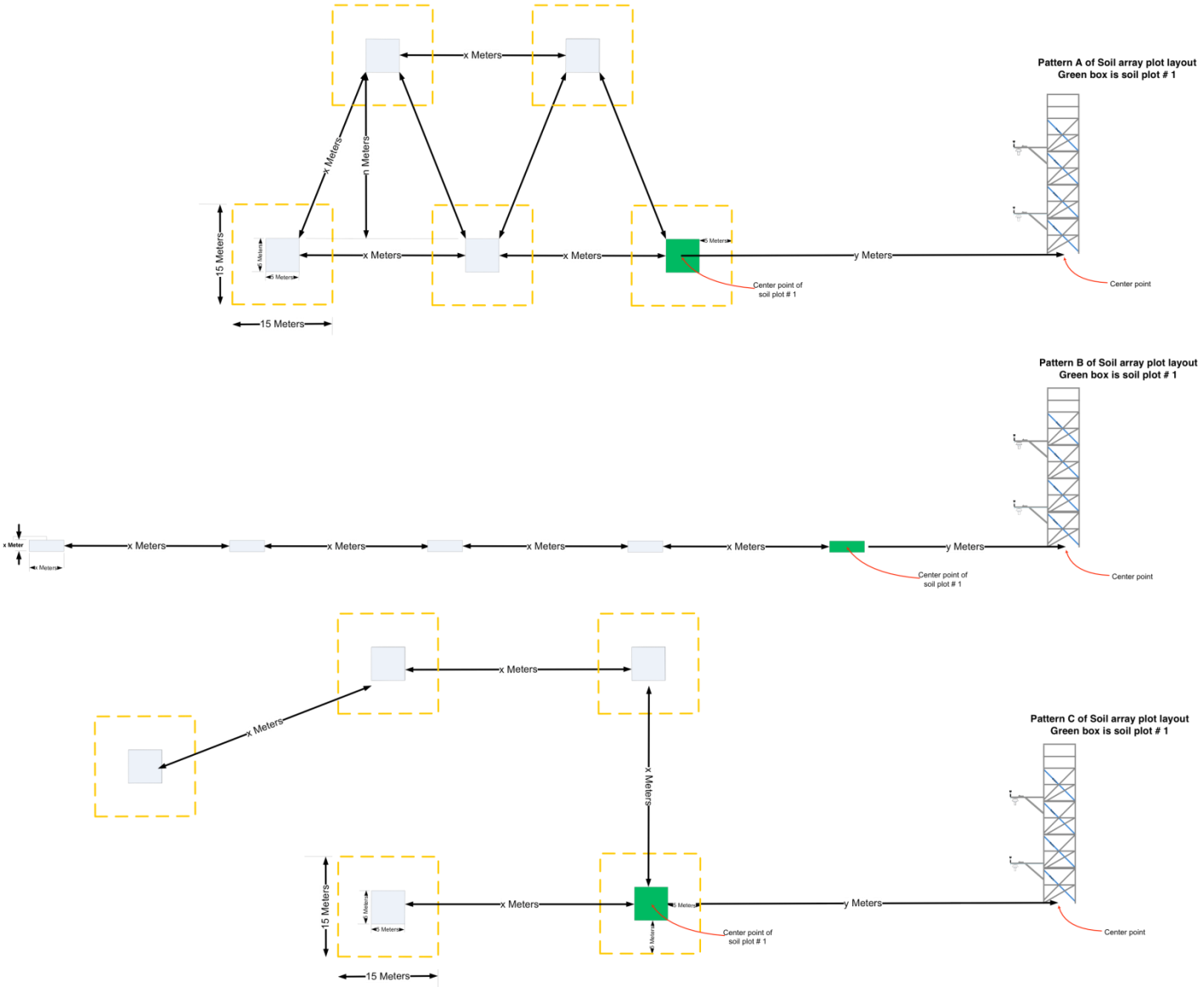


Figure 5. Generic patterns for the boardwalk configuration

These generic configurations are from the instrument hut to the tower based on 8 generic scenarios. The five options are based on anemometer boom orientation and the leeward side of the tower where the instrument hut is located. The tower entrance is always on the North side of the tower. Exact tower and instrument hut location and orientation will be specified at each location and presented in the site characterization document.


Pattern A of Soil array plot layout
Green box is soil plot # 1
x Meters
x Meters
n Meters
15 Meters
x Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
15 Meters
Pattern B of Soil array plot layout
Green box is soil plot # 1
x Meter
x Meters
x Meters
x Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
Pattern C of Soil array plot layout
Green box is soil plot # 1
x Meters
x Meters
x Meters
15 Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
15 Meters

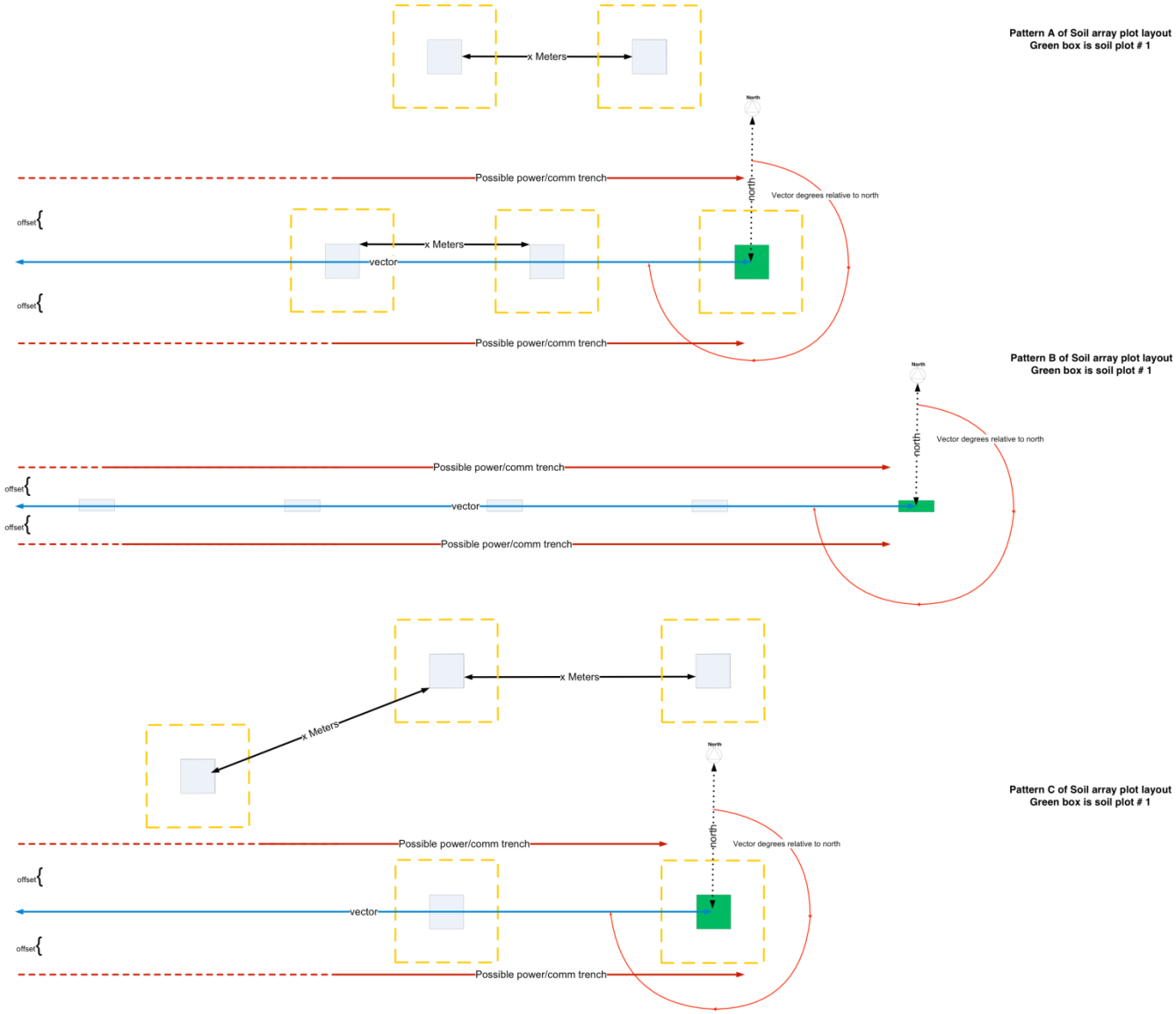

Pattern A of Soil array plot layout
Green box is soil plot # 1
x Meters
North
Possible power/comm trench
north
Vector degrees relative to north
offset
x Meters
vector
offset
Possible power/comm trench
Pattern B of Soil array plot layout
Green box is soil plot # 1
North
north
Vector degrees relative to north
Possible power/comm trench
offset
vector
offset
Possible power/comm trench
x Meters
x Meters
North
Pattern C of Soil array plot layout
Green box is soil plot # 1
Possible power/comm trench
north
Vector degrees relative to north
offset
vector
offset
Possible power/comm trench

Figure 6. Conceptual diagram of Soil Array Patterns

Outlines the orientation for the soil array and instrument hut from the center point of the tower. The x, y, z distances are i) the distance between soil plots, ii) distance between the tower centerpoint and the closest edge of soil plot, and iii) the distance between the tower centerpoint and the closest edge of the instrument hut, respectively. The yellow outline around each soil plot is the 5 m perimeter keep out zone.

6 APPENDIX A. FCC SUMMARY TABLES

Table A1. FCC Summary Table for FIU site components at D07 Walker Branch Core site

Site Component				**units**
Tower location	35.96412°	-84.28260°		Lat, Long
Tower height	38.0			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	35.96423°	-84.28256°		Lat, Long, vector from tower to IH, distance from tower
IH orientation[a]	90°-270°			Orientation vector
boom orientation[b]	180°			degrees
distance from center of tower to IH CPiont	355°	13	Option 8	vector, distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the north.			description
how the Bwalk intersects the tower access	Straight section of Boardwalk from the north of tower to IH			description
Air shed vector(s)[c]	247° to 293° and 68° to 90°	Clockwise from first angle		vector, notes
Boardwalk from AP to IH	yes			yes/none, notes
Boardwalk to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	none			yes/none
DFIR location	35.96180°	-84.28646°		Lat, Long
DFIR power supply	Line power, close by (few meters away)			description
Power and Communication line	10 m from edge of plot to the centerline of the power/comms line	whichever side is easiest[e], line above ground		offset, notes
Soil plot 1st location	35.96424°	-84.28266°		Lat, Long (center point)
Soil plot distance between plots (x)	40	14		x, y (m)
Soil array pattern and vector[d]	B	253°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	35.96453°	-84.28276°	1.1 m	Lat, Long, and expected depth
Soil profile pit alternative 1	35.96464°	-84.28323°	1.1 m	Lat, Long, and expected depth
Soil profile pit alternative 2	35.96431°	-84.28226°	1.1 m	Lat, Long, and expected depth

Fencing needs	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	none	description
Site management*	Upland Eastern Deciduous Forest	description
Any additional site specific information	On Nat'l Lab	description
Magnetic declination	5° 0' W changing by 0° 5' W y^{-1}	At time of site visit

Table A2. FCC Summary Table for FIU site components at D07 Mtn Lake Relocatable 1

Site Component				**units**
Tower location	37.37828°	-80.52484°		Lat, Long
Tower height	28.0			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	37.37816°	-80.52479°		Lat, Long, vector from tower to IH
IH orientation[a]	90°-270°			Orientation vector
boom orientation[b]	360°			degrees
distance from center of tower to IH CPiont	90°	14	Option 3	vector, distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the east.			description
how the Bwalk intersects the tower access	dogleg section of Boardwalk from the east of tower to IH			description
Air shed vector(s)[c]	250° to 315° (major) and 70° to 135°	Clockwise from first angle		vector, notes
Boardwalk from AP to IH	yes			yes/none, notes
Boardwalk to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	none			yes/none
DFIR location	na.			Lat, Long
DFIR power supply	na			description
Power and Communication line	10 m from edge of plot to the centerline of power/comms line	whichever side is easiest[e], line above ground		offset, notes
Soil plot 1st location	37.37840°	-80.52515°		Lat, Long (center point)
Soil plot distance between plots (x)	40 m	30 m		X, Y (m)
Soil array pattern and vector[d]	B	290°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	37.37778°	-80.52426°	1.40 m	Lat, Long, and expected depth
Soil profile pit alternative 1	37.37747°	-80.52451°	1.40 m	Lat, Long, and expected depth
Soil profile pit alternative 2	37.37710 °	-80.52477°	1.40 m	Lat, Long, and expected depth
Fencing needs	none			IH, Soil Arrays, Guy anchors
Presence of large grazing animals	none			description
Site management*	Eastern Deciduous Forest (Oak Dominant)			description

Any additional site specific information	Managed Forest	description
Magnetic declination	8° 2' W changing by 0° 2' W y^{-1}	At time of site visit

Table A3. FCC Summary Table for FIU site components at D07 Great Smoky Mountain National Park Relocatable 2

Site Component				**units**
Tower location	35.68896,	-83.50195		Lat, Long in degrees
Tower location	35° 41' 20.256"	-83° 30' 7.0194"		Lat, Long in deg, min, sec
Tower height	45.0			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	35.68905,	-83.50208		Lat, Long in degrees
Instrument Hut location	35° 41' 20.58"	-83° 30' 7.488"		Lat, Long in deg, min, sec
IH orientation[a]	135°- 315°			Orientation vector
boom orientation[b]	230°			degrees
distance from center of tower to IH CPiont		16	Option 7	distance (m), option #
Air shed vector(s)[c]	Wind mainly blows from SE and NW approximately along the valley line of 140°-320°.	No local wind data available to define the major airshed boundary. Nighttime drainage flows from S, SW and E along the mountain slopes are also expected.		vector, notes
Boardwalk from AP to IH	No BW, use gravel path from AP to interpretation platform (if built), well-defined marked path from the interpretation platform to instrument hut			yes/none, notes
how the Bwalk intersects the tower access	Boardwalk from IH to tower and intersects the tower on the north-face			description
Boardwalk to soil array	No BW, marked path to the soil array. No boardwalk or marked path to the individual soil plots			yes/none, notes
Boardwalk needed to DFIR	NA			yes/none
DFIR location	na.			Lat, Long
DFIR power supply	na			description
Power and Communication line	10 m from edge of plot to the centerline of power/comms line	whichever side is easiest[e], line above ground		offset, notes
Soil plot 1st location	35.688804,	-83.502149		Lat, Long (center point) in deg
Soil plot 1st location	35° 41' 19.6938"	-83° 30' 7.7364"		Lat, Long in deg, min, sec
Soil plot 2location	35.689193,	-83.502304		Lat, Long (center point) in deg

Soil plot 2 location	35° 41' 21.0948"	-83° 30' 8.2938"		Lat, Long in deg, min, sec
Soil plot 3location	35.689318,	-83.501828		Lat, Long (center point) in deg
Soil plot 3 location	35° 41' 21.5448"	-83° 30' 6.5808"		Lat, Long in deg, min, sec
Soil plot 4location	35.688930,	-83.501672		Lat, Long (center point) in deg
Soil plot 4 location	35° 41' 20.1474"	-83° 30' 6.0186"		Lat, Long in deg, min, sec
Soil plot 5 location	35.688544,	-83.501518		Lat, Long (center point) in deg
Soil plot 5 location	35° 41' 18.7584"	-83° 30' 5.4648"		Lat, Long in deg, min, sec
Soil plot distance between plots (x)	40 m	25 m		X, Y (m)
Soil array pattern and vector[d]	Non-standard pattern	Non-standard pattern, no vector is available		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	35.687624°,	-83.500381°	> 2 m	Lat, Long, and expected depth
				Lat, Long in deg, min, sec
Soil profile pit alternative 1	35.687965°,	-83.500045°	> 2 m	Lat, Long, and expected depth
				Lat, Long in deg, min, sec
Soil profile pit alternative 2	35.688301°,	-83.499678°	> 2 m	Lat, Long, and expected depth
				Lat, Long in deg, min, sec
Fencing needs	none			IH, Soil Arrays, Guy anchors
Presence of large grazing animals	Wild animals are likely presented			description
Site management*	Closed deciduous hardwood forest, diverse and dense understory. Manage as wildland			description
Any additional site specific information	1. An existing tower structure is currently at our tower location. National park will take it down prior the establishment of NEON tower. Exact nature and timing of its removal will be discussed with the park service. 2. Soil pit locations were picked using Google Earth and it was difficult to determine exactly how far they are from the road. Soil pit locations shall be close enough to the road to provide relatively easy access, but far enough from the road that the soil profile has not been disturbed by the road or activities associated with it. We fully expect that these soil pit locations will move based on input from the Great Smoky Mtn NP			description

	staff. Moreover, we do not know the boundaries of the conditional use area to best place the soil pits. It may be best to place them along the access path to the tower site itself.	
Magnetic declination	5° 34' W changing by 0° 4' W/year	At time of site visit

Notes;

[a]parallel to the long side of the IH

[b]From tower point to this direction

[c]Clockwise from first angle, recommend reviewing FIU site characterization summary

[d]From 1st plot toward other plots if pattern B, from 1st plot toward nearest neighbor (see diagram of the patterns)

[e]see Figure 4. Options for Soil Array.

Tower Height is for FIU requirements; actual tower height will increase toward the next section height

IH = instrument hut

AP = auxiliary portal

*burn information that may affect boardwalk, IH, or tower infrastructure, or other management activities